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भारतीय मानक

अर्धचालक युक्तियां – समाकलित परिपथ

भाग 2 अंकीय समाकलित परिपथ — आवश्यक रेटिंग और लक्षण

अनुभाग 1 सामान्य

Indian Standard

SEMICONDUCTOR DEVICES — INTEGRATED CIRCUITS

PART 2 DIGITAL INTEGRATED CIRCUITS — ESSENTIAL RATING AND CHARACTERISTICS

Section 1 General

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

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Semiconductor Devices and Integrated Circuits Sectional Committee, LTD 010

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FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Semiconductor Devices and Integrated Circuits Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

This standard is one of the series of standards on Integrated Circuits and deals with essential ratings and characteristics of digital integrated circuits. These are covered in the following three sections:

Section 1 General
Section 2 Integrated circuits memories
Section 3 Integrated circuit microprocessor

This standard deals with the general conditions, preferred voltage ratings, details of electrical ratings and characteristics, format for the presentation of data, etc, as a basis and guide for other standards dealing with specific digital integrated circuits. This is to be read in conjunction with IS 12970 (Part 1) : 1990.

A series of standards are being prepared on essential ratings and characteristics of digital integrated circuits. The object of this series of standards is to specify adequately the properties of the integrated circuits for the intended application and to facilitate comparison and choice between similar products. It is necessary that the individual specifications and the data sheet brought out by the manufacturers which describe performance of these integrated circuits, should contain, as a minimum, certain information on essential ratings, characteristics and other parameters and that this information should be quoted in the same terms in all specifications or data sheets. The adoption of this series of standards would ensure such a uniform presentation of integrated circuits ratings and charateristics.

This standard is based on IEC Pub 748-2 'Semiconductor devices integrated circuits : Part 2 Digital integrated circuits' issued by the International Electrotechnical Commission (IEC).

It is proposed to withdraw the existing Indian Standard, namely, IS 7441 (Part 1) : 1974, dealing with essential ratings and characteristics of digital integrated circuits, as soon as the clauses therein are covered in the new series [IS 12970 (Part 2/Sections 1 to 3)].

In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

Indian Standard
SEMICONDUCTOR DEVICES — INTEGRATED CIRCUITS

PART 2 DIGITAL INTEGRATED CIRCUITS — ESSENTIAL RATINGS AND CHARACTERISTICS

Section 1 General

1 SCOPE

1.1 This standard (Part 2/Sec 1) cover essential ratings and characteristics of combinatorial and sequential digital integrated circuits, both bipolar and MOS circuits, unless otherwise specified. They do not include a.c. coupled digital integrated circuits.

1.2 An example of specification of characteristics according to this standard is given in Annex A.

2 REFERENCES

The following Indian Standards listed below are necessary adjuncts to this standard:

IS No.	*Title*
1885 (Part 7/ Sec 5) : 1971	Electrotechnical vocabulary : Part 7 Semiconductor devices, Section 5 Integrated circuits and microelectronics
3715 (Part 1) : 1971	Letter symbols for semiconductor devices : Part 1 General aspects (*first revision*)
5000 Series	Dimensions of semiconductor devices
12970 (Part 1) : 1990	Semiconductor devices — Integrated circuits : Part 1 General

3 TERMINOLOGY

For the purpose of this standard, the terms and definitions given in IS 1885 (Part 7/Sec 5) : 1971 shall be applicable in addition to **3** of IS 12970 (Part 1) : 1990.

4 LETTER SYMBOLS

For the purpose of this standard (Part 2/Sec 1), the letter symbols given in IS 3715 (Part 1) : 1971 shall be applicable.

5 CIRCUIT IDENTIFICATION AND DESCRIPTION

5.1 Designation and Type

5.2 Technology

The manufacturing technology, for example, semiconductor monolithic integrated circuit, thin film integrated circuit, hybrid integrated circuit, micro-assembly, should be stated. This statement should include details of the semiconductor technologies such as NMOS, CMOS, Schottky TTL or I^2L.

5.3 Package Identification

5.3.1 Either a reference to the outline covered in IS 5000, or drawing of non-standard package including terminal numbering.

5.3.2 Principal package material, for example, ceramic, plastic, glass.

5.3.3 Terminal identification, terminal numbers and associated functions.

6 FUNCTIONAL SPECIFICATIONS

6.1 Block Diagram

A block diagram or equivalent circuit information of the digital integrated circuit shall be given.

Example:

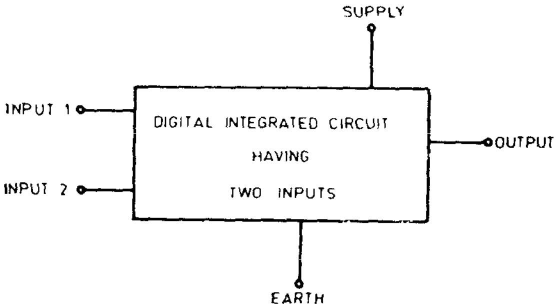


FIG. 1

The following terminals shall be distinguished:

a) Supply terminals, that is, terminals intended to be connected to the power supplies.

b) Input and output terminals, that is, terminals into or out of which signals are passed. The term "signal" includes both pulse and more complex waveforms.

c) Where appropriate, other terminals that can be used to control or modify the characteristics of the circuit.

d) Blank terminals.

The block diagram should identify the function of each external connection and, where no ambiguity can occur, can also show the terminal numbers. If the encapsulation has metallic parts, any connection to them from external terminals should be indicated. The connections with any associated external electrical elements should be stated, where necessary.

As additional information, the complete electrical diagram can be reproduced, but not necessarily with indications of the values of the circuits components.

6.2 Functional Description

The function performed by the circuit shall be specified, for example, in the form of a function table.

Example:

A function table of a digital integrated circuit having two inputs and performing the NAND function.

Input 1	Input 2	Output
H	H	L
H	L	H
L	H	H
L	L	H

Unless otherwise stated, H and L refer to voltage.

6.3 Complex Structures

Where appropriate, for complex structures in a single encapsulation, the permissible external interconnections of the terminals, the external elements such as load resistances to be connected and the principal function which may be performed thereby, shall be stated.

7 RATINGS (LIMITING VALUES)

In satisfying the following clauses, if maximum and/or minimum values are quoted, the manufacturer must indicate whether he refers to the absolute magnitude or to the algebraic value of the quantity.

The ratings given must cover the operation of the integrated circuit over the specified range of operating temperatures. Where such ratings are temperature-dependent, this dependence shall be indicated.

7.1 Continuous Voltages and Currents

7.1.1 Limiting value(s) of the continuous voltage(s) at the supply terminal(s) with respect to a specified electrical reference point (*see* Note).

7.1.2 Where appropriate, limiting voltage between specified supply terminals (*see* Note).

7.1.3 When more than one voltage supply is required, a statement shall be made as to whether the sequence in which these supplies are applied is significant, if so, the sequence should be stated.

7.1.4 Where the current through any terminal is not limited sufficiently by the voltage rating, a limiting current rating for that terminal shall also be given (*see* Note).

7.1.5 Where appropriate, limiting values of the continuous conditions at the input and/or output terminals.

NOTE — When more than one supply is needed, it may be necessary to state the combinations of ratings for these supply voltages and currents.

7.2 Non-continuous Voltages and Currents

7.2.1 If the values given in **7.1.1**, **7.1.2** and **7.1.4** may be exceeded under transient conditions, then the permissible excess values and their duration shall be stated.

7.2.2 Limiting values of input and/or output voltage and current and, where appropriate, time limitations, under specified worst-case conditions.

7.3 Temperature

7.3.1 *Minimum and Maximum Ambient or Reference-Point Operating Temperatures*

7.3.2 *Minimum and Maximum Storage Temperatures*

7.4 Capability of Sustaining a Short Circuit

Where appropriate, the maximum duration of a short circuit between each output terminal and any supply terminal (or earth) should be given under specified worst-case conditions of operation.

8 RECOMMENDED OPERATING CONDITIONS (WITHIN THE SPECIFIED OPERATING TEMPERATURE RANGE)

8.1 The range of values of supply voltage(s) : in terms of a nominal value, plus and minus given deviations (tolerances) [the plus and minus deviations (tolerances) need not be identical and should be stated].

The nominal values and the permitted deviations (tolerances) are to be taken from **5.4.1** of IS 12970 (Part 1) : 1990.

8.2 The input pulse conditions, voltage and/or current levels and waveforms and, where appropriate, the time relations of the input signals.

8.3 Where appropriate, the continuous voltage and/or current bias conditions at all input terminals.

8.4 Where appropriate, the continuous voltage and/or current bias conditions at all output terminals.

8.5 Where appropriate, the values of external impedances required at the input and output terminals.

8.6 Pulse conditions of the clock(s). Where appropriate, such conditions should include voltage levels, pulse waveform conditions and time interrelations of the pulses.

9 STATIC ELECTRICAL CHARACTERISTICS FOR BIPOLAR INTEGRATED CIRCUITS

Each electrical characteristic of **9** shall be stated under specified electrical worst-case conditions, with respect to the recommended range of supply voltage(s), as stated in **8.1**, and

a) over the specified range of operating temperatures, or

b) at a temperature of 25°C, and a maximum and minimum operating temperatures.

9.1 Essential Characteristics of the Digital Voltage Signals

The voltage characteristics are expressed in terms of four ranges, each of which is specified by two limits. Thus, eight values of voltage are needed.

For each state of the voltage variable, two ranges are defined : the guaranteed range at the output and the permitted range at the input. Any voltage within the permitted range applied to the inputs causes the output voltage to remain within the guaranteed range corresponding to the resulting state shown by the function table. The following voltage characteristics are therefore required:

V_{OHA} = the most positive (least negative) value of the guaranteed high state voltage range at the output.

NOTE — In many practical cases, a simplification can be made by setting V_{OHA} equal to the most positive value of the most positive power supply voltage (or to zero when there are only negative supply voltages). This condition is implied when no indication is given on V_{OHA}.

V_{OHB} = the least positive (most negative) value of the guaranteed high state voltage range at the output.

V_{OLA} = the most positive (least negative) value of the guaranteed low state voltage range at the output.

V_{OLB} = the least positive (most negative) value of the guaranteed low state voltage range at the output.

NOTE — In many practical cases, a simplification can be made by setting V_{OLB} equal to the most negative value of the most negative power supply voltage (or to zero when there are only positive supply voltages). This condition is implied when no indication is given on V_{OLB}.

V_{IHA} = the most positive (least negative) value of the permitted high state voltage range at the input.

NOTE — When no indication is given on V_{IHA}, it is supposed that $V_{IHA} = V_{OHA}$.

V_{IHB} = the least positive (most negative) value of the permitted high state voltage range at the input.

V_{ILA} = the most positive (least negative) value of the permitted low state voltage range at the input.

V_{ILB} = the least positive (most negative) value of the permitted low state voltage range at the input.

NOTE — When no indication is given on V_{ILB}, it is supposed that $V_{ILB} = V_{OLB}$.

9.1.1 *Essential Characteristics of Circuits with Inputs Having Hysteresis (for example, Schmitt-trigger circuit)*

V_{IT+}, V_{ITP} = positive-going (input) threshold voltage

V_{IT+A}, V_{ITPA} = the most positive (least negative) value of the guaranteed postive-going (input) threshold voltage range.

V_{IT+B}, V_{ITPB} = the least positive (most negative) value of the guaranteed positive-going (input) threshold voltage range.

V_{IT-}, V_{ITN} = negative-going (input) threshold voltage.

V_{IT-A}, V_{ITNA} = the most positive (least negative) value of the guaranteed negative-going (input) threshold voltage range.

V_{IT-B}, V_{ITNB} = the least positive (most negative) value of the guaranteed negative-going (input) threshold voltage range.

NOTE — The term "hysteresis", often used in date sheets, denotes the difference between the positive-going and the negative going (input) threshold voltages.

$$V_{hys} = V_{IT+} - V_{IT-}$$

or

$$V_{hys} = V_{ITP} - V_{ITN}$$

9.2 Input Clamping Voltage (where appropriate)

Maximum value of input clamping voltage at a specified value of input current.

NOTE — This characteristic should be specified for circuits having clamping diodes attached to one or more inputs, for example, input-clamped TTL.

9.3 Essential Characteristics for Input and Output Currents

9.3.1 *Essential Characteristics for All Digital Integrated Circuits*

Associated with each of the four output voltages is a current driving or sinking capability determined by the design of the circuit.

It is necessary therefore to specify limit values of current associated with the four output voltages.

Taking as a convention that current flowing into a terminal is positive, and that out of a terminal is negative, the required currents are as follows:

I_{OHB} at V_{OHA} = Least positive (most negative) value of the output current when V_{OHA} is present at the output considered and when the voltages applied to the inputs have the worst-case value within the appropriate range V_{IHA} to V_{IHB} and/or V_{ILA} to V_{ILB} corresponding to the input states necessary for the output to be in the high state as shown by the function table.

NOTE — This value is not necessary if V_{OHA} is equal to the most positive value of the most positive power supply voltage.

I_{OHA} at V_{OHB} = Most positive (least negative) value of the output current when V_{OHB} is present at the output considered and when the voltages applied to the inputs have the worst-case value within the appropriate range V_{IHA} to V_{IHB} and/or V_{ILA} to V_{ILB} corresponding to the input states necessary for the output to be in the high state as shown by the function table.

I_{OLB} at V_{OLA} = least positive (most negative) value of the output current when V_{OLA} is present at the output considered and when the voltages applied to the inputs have the worst-case value within the appropriate range V_{IHA} to V_{IHB} and/or V_{ILA} to V_{ILB} corresponding to the input states necessary for the output to be in the low state as shown by the function table.

I_{OLA} at V_{OLB} = most positive (least negative) value of the output current when V_{OLB} is present at the output considered and when the voltages applied to the inputs have the worst-case value within the appropriate range V_{IHA} to V_{IHB} and/or V_{ILA} to V_{ILB} corresponding to the input states necessary for the output to be in the low state as shown by the function table.

NOTE — This value is not necessary if V_{OLB} is equal to the most negative value of the most negative power supply voltage.

In a similar way, the inputs of the circuit will sink or drive a certain current when they have any of the four input voltages applied to them. At the inputs, the values of current limits are as follows:

I_{IHB} at V_{OHA} = least positive (most negative) value of the input current when V_{OHA} is applied to the input considered and when the voltages applied to the other inputs have the worst-case value within the appropriate range V_{IHA} to V_{IHB} and/or V_{ILA} to V_{ILB}.

NOTE — This characteristic is not mandatory in every case, for example, when V_{OHA} is equal to the most positive value of the most positive power supply voltage, or for ECL circuits.

I_{IHA} at V_{OHB} = most positive (least negative) value of the input current when a specified worst-case voltage in the range V_{OHB} to V_{IHA} is applied to the input considered and when the voltages applied to the other inputs have the worst-case value within the appropriate range V_{IHA} to V_{IHB} and/or V_{ILA} to V_{ILB}.

NOTE — The worst-case voltage is that voltage within the permitted range that increases the input current to a maximum.

I_{ILB} at V_{OLA} = least positive (most negative) value of the input current when a specified worst-case voltage in the range V_{ILB} to V_{OLA} is applied to the input considered and when the voltages applied to the other input have the worst-case value within the appropriate range V_{IHA} to V_{IHB} and/or V_{ILA} to V_{ILB}.

NOTE — The worst-case voltage is that voltage within the permitted range that increases the input current to a maximum.

I_{ILA} at V_{OLB} = most positive (least negative) value of the input current when V_{OLB} is applied to the input considered and when the voltages applied to the other inputs have the worst-case value within the appropriate range V_{IHA} to V_{IHB} and/or V_{ILA} to V_{ILB}.

NOTE — This characteristic is not mandatory in every case, for example, when V_{OLB} is equal to the most negative value of the most negative power supply voltage, or for ECL circuits.

In general, for both output and input terminals, four points in the voltage-current plane must be specified (for example, *see* Fig. 2 and 3). The specification may be written using one of the following three methods:

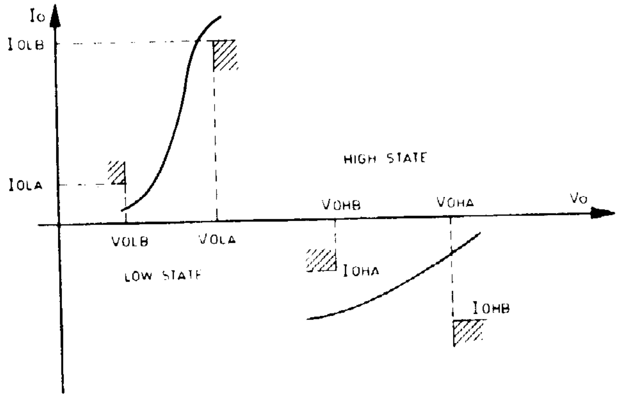
a) by applying a specified reference current and measuring the resulting voltage;

b) by applying a specified reference voltage and measuring the resulting current, and

NOTE — In Fig. 2 and 3, the axes do not necessarily represent zero voltage or current.

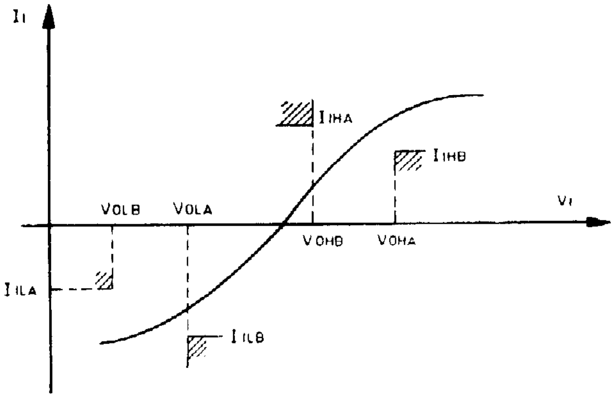
c) by applying a specified reference voltage through a specified load resistor and measuring either voltage or current at the output terminal.

NOTE — Method (c) should be adopted only when the circuit is specified for driving a defined load.



Note — The axes do not necessarily represent zero voltage or current.

FIG. 2 OUTPUT CURRENTS ASSOCIATED WITH OUTPUT VOLTAGES



Note — The axes do not necessarily represent zero voltage or current.

FIG. 3 INPUT CURRENTS ASSOCIATED WITH INPUT VOLTAGES

9.3.2 *Additional Characteristics for Digital Integrated Circuits having Three-State Outputs*

Under consideration.

9.4 Applied Conditions for Worst Case

The boundaries of the input and output characteristics curves must be guaranteed in the electrical worst case:

a) over the specified range of operating temperatures, or

b) at a temperature of 25°C, and at maximum and minimum operating temperatures.

This is done by stating the values of the foregoing specified points under the worst-case conditions. The worst-case conditions in general are different for each point. These conditions, which are allowed to vary independently, each within a stated range, and which determine the electrical worst-case are:

a) supply voltages within the specified recommended range; and

b) conditions to be applied to an input terminal other than those directly concerned by the measurement, that is, a voltage chosen from the appropriate range V_{IHA} to V_{IHB} and/or V_{ILA} to V_{ILB}.

10 STATIC AND QUASI-STATIC ELECTRICAL CHARACTERISTICS FOR MOS INTEGRATED CIRCUITS

Each electrical characteristic of **10** shall be stated under specified electrical worst-case conditions, with respect to the recommended range of supply voltage(s), as stated in **8.1** and:

a) over the specified range of operating temperatures, or

b) at a temperature of 25°C, and at maximum and minimum operating temperatures.

10.1 Essential Characteristics of the Digital Voltage Signals

The voltage characteristics are expressed in terms of four ranges, each of which is specified by two limits. Thus, eight values of voltage are needed.

For each state of the voltage variable, two ranges are defined: the guaranteed range at the output and the permitted range at the input. Any voltage within the permitted range applied to the input causes the output voltage to remain within the guaranteed range corresponding to the resulting state shown by the function table. The following voltage characteristics are therefore required:

V_{OHA} = the most positive (least negative) value of the guaranteed high state voltage range at the output.

NOTE — In many practical cases, a simplification can be made by setting V_{OHA} equal to the most positive value of the most positive power supply voltage (or to zero when there are only negative supply voltages). This condition is implied when no indication is given on V_{OHA}.

V_{OHB} = The least positive (most negative) value of the guaranteed high state voltage range at the output.

V_{OLA} = the most positive (least negative) value of the guaranteed low state voltage range at the output.

V_{OLB} = the least positive (most negative) value of the guaranteed low state voltage range at the output.

NOTE — In many practical cases, a simplification can be made by setting V_{OLB} equal to the most negative value of the most negative power supply voltage (or to zero when there are only positive supply voltages).

This condition is implied when no indication is given on V_{OLB}.

V_{IHA} = The most positive (least negative) value of the permitted high state voltage range at the input.

NOTE — When no indication is given on V_{IHA}, it is supposed that $V_{IHA} = V_{OHA}$.

V_{IHB} = The least positive (most negative) value of the permitted high state voltage range at the input.

V_{ILA} = The most positive (least negative) value of the permitted low state voltage range at the input.

V_{ILB} = The least positive (most negative) value of the permitted low state voltage range at the input.

NOTE — When no indication is given on V_{ILB}, it is supposed that $V_{ILB} = V_{OLB}$.

10.2 Essential Characteristics for Currents

10.2.1 *Static Input Current*

Maximum value, under specified static conditions.

10.2.2 *Output Currents*

The output currents that shall be stated correspond to those obtained in applying one of the voltages V_{OHA}, V_{QHB}, V_{OLA}, V_{OLB} to the terminal at which the current is measured.

The following currents should therefore be stated: I_{OHB} at V_{OHA}, I_{OHA} at V_{OHB}, I_{OLB} at V_{OLA}, I_{OLA} at V_{OLB}.

10.2.3 *Output Leakage Current (Where Appropriate)*

Maximum value, under specified conditions.

11 DYNAMIC ELECTRICAL CHARACTERISTICS

Each electrical characteristic of **11.2** should be stated under specified electrical worst-case conditions with respect to the recommended range of supply voltages as stated in **8.1**.

Limit values, or if these are not mutually acceptable to manufacturer and user, typical values should be stated either:

a) over the specified range of operating temperatures (for example, as a curve), or

b) at a temperature of 25°C, and at the maximum and the minimum operating temperatures.

Alternative (b) should be used only if the worst-case value of the characteristic over the whole temperature range can be deduced from the values given at the specified temperatures.

In all cases, limit values applicable at 25°C should be stated.

11.1 Introduction

Switching times of digital integrated circuits are characterized by propagation times and transition times. Propagation times are always required, but the necessity of specifying transition times depends on:

a) the value of the transition time relative to the propagation time, and

b) the value of the transition time relative to an arbitrary low value, for example, 10 ns (*see* **11.2.2**).

These switching times are intended to provide information on the performance of the integrated circuit in typical system applications. However, in the interests of exact measurements and standard specifications, methods of measurement using defined driving pulse characteristics and loads comprising passive circuit elements should be used.

The switching characteristics of **11.2** and the timing requirements of **11.3** are given in general terms but, for sequential circuits, it may be necessary to specify more than one value for some of the times listed (for example, for different propagation paths). In addition, for a particular circuit, it may be necessary to specify more than one value of the same time with reference to different specified voltage levels.

The voltage levels to be used to define the switching times are given in **9.1**.

11.2 Times Characterizing the Response of the Circuit

11.2.1 *Propagation Times*

The following propagation times should be stated under specified conditions (*see* Note 1 of **11.2.2**):

a) t_{PHL} : propagation time with output going to low level; maximum and minimum values; and

b) t_{PLH} : propagation time with output going to high level; maximum and minimum values.

If there are several different logic information paths, separate times should be specified for each path.

The following information should be given as typical data:

a) variation of propagation times with load current or, where appropriate, load resistance;

b) variation of propagation times at a specified load current or, where appropriate, load resistance as a function of load capacitance.

11.2.2 *Transition Times*

Transition times shall be stated under specified conditions (*see* Note 1), as follows:

a) if the typical value of transition time is comparable to (*see* Note 2), or greater than, the typical value of propagation time, then a maximum value of transition time should be stated; and

b) if the typical value of transition time is less than 10 ns, a minimum value should be stated (*see* Note 3).

If both conditions (a) and (b) are fulfilled, then both minimum and maximum values should be stated. If neither conditions (a) nor (b) is fulfilled, then no value of transition time is required.

Transition times, when required, shall be stated for both directions of transition (that is, t_{THL} and t_{TLH} should be stated).

NOTES

1 The specified conditions of measurement should include the characteristics of the pulse generator and oscilloscope (or other appropriate measuring system), and the configuration and component values of the output loading network.

2 The transition time is considered comparable to propagation time if its value exceeds 50 percent of the value of propagation time.

3 When very short transition times occur, these may give rise to overshoot and coupling problems in practice.

The following information should be given as typical data:

— transition time as a function of load capacitance.

11.3 Requirements at the Inputs to Ensure Correct Sequential Operation

Correct sequential operation may consist of:

a) a change of state of one or more outputs, or

b) holding all outputs in their previous state, and/or

c) a change in the state of preparedness of the circuit.

11.3.1 *Time Characterizing the Limiting Waveform of the Applied Signal to an Input Terminal (with Other Inputs at Specified Constant Levels)*

a) *Duration for the high level* (t_1), (*see* Fig. 6)

Minimum value for a signal having specified high state and low state levels applied to the specified input terminal. The duration of the low level should be sufficiently long that decreasing its value does not affect the result obtained.

b) *Duration for the low level* (t_2) (*see* Fig. 6)

Minimum value for a signal having specified high state and low state levels applied to the specified input terminal. The duration of the high level should be sufficiently long that decreasing its value does not affect the result obtained.

c) *Duration for the high level* (t_1) (*see* Fig. 6)

Maximum value for a signal having specified high state and low state levels applied to the specified input terminal. The duration of the low level should be sufficiently long that decreasing its value does not affect the result obtained.

d) *Duration for the low level* (t_2) (*see* Fig. 6)

Maximum value for a signal having specified high state and low state levels applied to the specified input terminal. The duration of the high level should be sufficiently long that decreasing its value does not affect the result obtained.

e) *Rate of change, or rise and/or fall times, of the input signal*

Minimum and maximum values for a signal having specified high state and low state levels applied to the specified input terminal.

11.3.2 *Necessary Time Relations Between Two Input Signals*

When the effect of a change of state of an input signal E_1 is determined by the state of other input signal E_j (where $j = 2$ to n, n being the number of inputs), the following times necessary to ensure correct sequential operation should be stated for each input E_j.

NOTES

1 Signal E_1 refers to a signal applied to any input terminal arbitrarily designated here as 1.

2 In the general case, several time intervals between different specified levels of the signal E_1 and the signal E_j may have to be stated.

a) *Set-up time* (t_{su})

Minimum value and, where appropriate, maximum value.

NOTES

1 The set-up time is the time interval, measured with reference to some specified level of the signal E_1, for which the signal E_j is present before the signal E_1 is applied. It is measured between specified levels on the signals E_1 and E_j as indicated in Fig. 4.

2 The set-up time may have a negative value.

b) *Hold time* (t_h)

Minimum value and, where appropriate, maximum value.

NOTES

1 The hold time is the time interval, measured with reference to some specified level of the signal E_1, for which the signal E_j is present after the signal E_1 has been removed. It is measured between specified levels on the signals E_1 and E_j as indicated in Fig. 5.

2 The hold time may have a negative value.

11.3.3 *Necessary Time Relations Between Two Successive Signals Applied to the Same Input*

a) *Resolution time* (t_{res})

Minimum value.

NOTE — The resolution time is the time interval between the cessation of one input pulse and the commencement of the next input pulse applied to the same input terminal, each having a duration as defined in **11.3** (*see* Fig. 6).

b) *Operating frequency*

Minimum and maximum values.

NOTE — The frequency of a signal is that of the signal which may be applied to an input terminal for a specified duty cycle and for specified (possibly sequential) conditions applied to the other input terminals.

11.4 Input and Output Impedances

11.4.1 *Input Capacitance for Large-Signal Operation*

Maximum and/or typical value(s) with the input signal voltage (or current) changing from a high state to a low state or the reverse, under the following specified conditions:

a) output loading conditions and loading conditions on other input terminals;

b) input pulse conditions (amplitude, frequency, rise and fall times, etc); and

c) supply voltage(s).

11.4.2 *Output Capacitance for Large-Signal Operation (Limited to High Output Impedance Applications, such as Wired OR Configuration)*

Maximum and/or typical value(s) with the voltage (or current) at the output terminal changing from a high state to a low state or the reverse, under the following specified conditions:

a) input loading conditions and loading conditions on other output terminals;

b) input pulse conditions (amplitude, frequency, rise and fall times, etc); and

c) supply voltage(s).

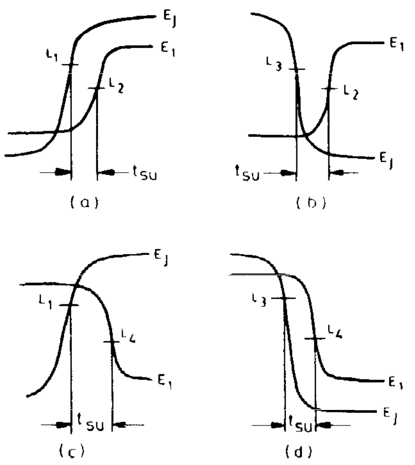
11.4.3 *Input Resistance For Large-Signal Operation (For Non-Saturated Circuits and Limited to High-Speed Applications)*

Minimum and/or typical value(s) with the voltage (or current) at the input terminal changing from a high state to a low state or the reverse, under the following specified conditions:

a) output loading conditions and loading conditions on other input terminals;

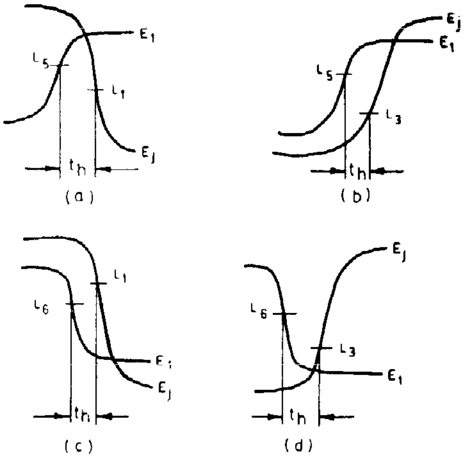
b) input pulse conditions (amplitude, frequency, rise and fall times, etc); and

c) supply voltage(s).



NOTE — Neutral symbols L_1 to L_4 have been used to indicate levels.

FIG. 4 SET-UP TIME t_{su}



NOTE — Neutral symbols L_1 to L_6 have been used to indicate levels.

FIG. 5 HOLD TIME t_h

11.4.4 *Output Resistance for Large-Signal Operation (For Non-Saturated Circuits and Limited to High-Speed Applications)*

Minimum and/or typical value(s) with the voltage (or current) at the output terminal changing from a high state to a low state or the reverse, under the following specified conditions:

a) input loading conditions and loading conditions on other output terminals;

b) input pulse conditions (amplitude, frequency, rise and fall times, etc);

c) supply voltage(s).

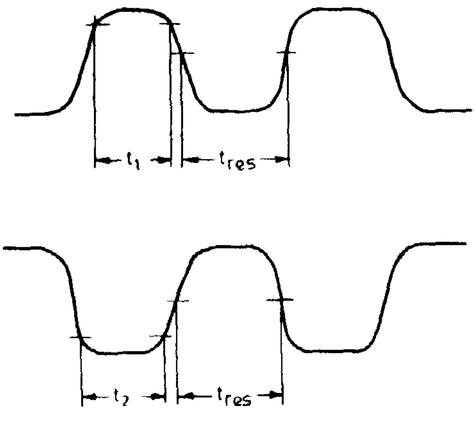


FIG. 6 RESOLUTION TIME t_{res}

12 TOTAL POWER OR CURRENTS PROVIDED FROM THE SUPPLIES

Typical and maximum values under specified operating conditions.

13 TOTAL CURRENT DRAWN FROM THE POWER SUPPLIES (DYNAMIC OPERATION)

Curve(s) showing the typical value(s) of current required from the power supply(ies) versus the pulse repetition frequency at 50 percent duty cycle, or typical values at two specified pulse repetition frequencies. This (these) shall be given under specified recommended operating conditions.

Where appropriate, the above information shall also be given for clock inputs acting as pulsed power supplies.

14 COMMAND PULSE INFORMATION (where appropriate)

Term under consideration.

15 INSULATION RESISTANCE

Where appropriate, minimum value at a specified voltage. The measuring method must be specified.

16 MECHANICAL RATINGS, CHARACTERISTICS AND OTHER DATA

Provision of **5.5** of IS 12970 (Part 1) : 1990 shall apply.

17 SUPPLEMENTARY INFORMATION

17.1 Output Loading Capability

The maximum number of specified loads that can be driven from each output. This information shall be given for more than one type of load.

17.2 Noise Margins

In a system composed solely of units similar to the one under consideration, the noise margins result directly from the eight values of voltages previously specified. There are four noise margins defined as:

$$M_1 = V_{IHA} - V_{OHA} \quad M_3 = V_{ILA} - V_{OLA}$$

$$M_2 = V_{OHB} - V_{IHB} \quad M_4 = V_{OLB} - V_{ILB}$$

In many practical systems, the "outer" noise margins M_1 and M_4 are of little concern. Therefore, when a noise margin is indicated without further qualification, it should correspond to the smaller of values of M_2 and M_3.

17.3 Interconnections of Digital Integrated Circuits

Examples of logic operations which may be performed by interconnecting similar units should be stated.

18 HANDLING PRECAUTIONS

Appropriate precautions should be taken to protect the device against high electrostatic voltages or large electromagnetic fields (*see* **8** of IS 12970 (Part 1) : 1990

ANNEX A

(*Clause* 1.2)

SPECIFICATION OF CHARACTERISTICS

A-0 An example of the specification of a general circuit in accordance with the preceding is as follows.

A-1 The following electrical characteristics shall be stated under specified electrical worst-case conditions with respect to the recommended range of supply voltages as given in **8.1** and

a) over the specified range of operating temperatures, or

b) at a temperature of 25°C and at maximum and minimum operating temperatures.

Output	*Reference value of current*	*Limit (measured) value of voltage*
High state	I_{OHB}	V_{OHA}
	I_{OHA}	V_{OHB} (*see* NOTE 1)
Low state	I_{OLB}	V_{OLA}
	I_{OLA}	V_{OLB} (*see* NOTE 2)
High state	V_{OHA}	I_{IHB} (*see* NOTE 1)
	V_{OHB}	I_{IHA}
Low state	V_{OLA}	I_{ILB}
	V_{OLB}	I_{ILA} (*see* NOTE 1)

NOTES

1 This pair of value is not necessary of V_{OHA} is equal to the most positive value of the most positive power supply voltage.

2 This pair of value is not necessary of V_{OLB} is equal to the most negative value of the most negative power supply voltage.

Standard Mark

The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act, 1986* and the Rules and Regulations made thereunder. The Standard Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well defined system of inspection, testing and quality control which is devised and supervised by BIS and operated by the producer. Standard marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.